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DESCRIPTION OF GULTON INDUSTRIES, INCORPORATED TOWED VEHICLE IN--ETC(U)
FEB 66 J ROBICHAUD

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U. S. Navy Underwater Sound Laboratory
Fort Trumbull, New London, Connecticut

(6) DESCRIPTION OF GULTON INDUSTRIES, INCORPORATED TOWED VEHICLE INSTRUMENTATION SYSTEM

By

(10) John Robichaud

USL Technical Memorandum No. 2132-902-66

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INTRODUCTION

This memorandum describes a Noise Analysis Data System designed for towed vehicle application. The system was developed by Gulton Industries, Incorporated,(see references (a), (b) and (c)) under Navy Contract N140(70024)76034B, as the result of an unsolicited proposal by that company (reference (a)). It was delivered to the Laboratory in the first quarter fiscal 65, and was used in sea tests aboard the USS WITEK (DD-848) in February 1965. The results of the sea tests will be reported in a subsequent memorandum.

GENERAL INFORMATION

(9) Technical memo.

The Gulton Noise Analysis Data System is designed to select, analyse, and transmit data from a towed vehicle to the towing ship, utilizing only four conductors of the tow cable.

Twelve data-acquisition channels are available which are monitored at the on-deck console of the system. Sensor inputs to the data channels from the underwater unit include three accelerometer, three hydrophone, and six potentiometric transducers. The input channels are monitored sequentially, with the selection of a specific channel for analysis controlled by the operator at the console. Data is stored on magnetic tape and simultaneously printed out by the USL Automated Data System (ADS).

The hydrophone and accelerometer channels are analysed in 1/3-octave bands which are automatically sequenced in frequency from 37.5 to 19200 cps, at the rate of one 1/3-octave band per second.

The potentiometric channels can be monitored continuously for any period of time required. The output of the potentiometric channels is proportional to the unbalance of a bridge circuit, and is not subject to frequency analysis.

ON-DECK UNIT

The on-deck unit is made up of seven rack-mounted components, as shown in Figure 1. From top to bottom they are:

a. Crown Tape Recorder, Model BX800, with dual-channel capability and two record-playback amplifiers.

b. Preamp No. 1, connected into the system to record the 5.4 KC voltage control oscillator information-carrying signal from the fish unit. Playback through the discriminator permits the data to be analyzed through the ADS.

c. Preamp No. 2, wired to a microphone input for voice commentary.

d. Programmer Control Unit, designed and constructed by Gulton Industries, Incorporated, containing the digital control circuitry and control switches for channel advance, clear, skip, and calibrate functions. Pilot lamps for indication of channel-in-use are also provided on this panel.

e. Electro-Mechanical Research, Incorporated, Discriminator, Model 189-D. A Philbrick Universal Stabilized Amplifier, Model USA-3, is used at the output of the discriminator to provide the voltage requirements to drive the ADS.

f. Kepco Voltage-Regulated Power Supply, Model SM75-5, modified for a maximum of 69 V output.

g. Utility Panel, containing the main power input and connectors for cables to the underwater unit and the ADS. The Synchronization Pulser that provides the step input to the Automated Data System is also located on this panel.

FISH UNIT

The instrument package for deep submergence is a stainless steel cylinder 12 inches in diameter and 18 inches high, with external connections made through Marsh and Marine XS-series bulkhead connectors (See figure 2). Attachment of the waterproof sensors and connection of the

tow cable are accomplished with mating RM-series connectors. A 4-pin Marsh and Marine bulkhead-connect is also supplied for insertion of a calibration signal into the system. Two of the pins provide switch contacts for closing the calibration relay, which connects a 40 db attenuator pad into the low side of the transducer connected to the preamplifier. The other two pins provide the input terminals to the 40 db pad for the external calibration signal. Calibration of the hydrophone and accelerometer channels can thus be performed with the transducers in the input circuit. The entire assembly is designed and tested for normal operation to a submerged depth of one thousand feet (450 lbs. per square inch). Installation in the towed body is accomplished with the cradle bracket assembly, as shown in figure 3.

SYSTEM OPERATION

SIGNAL PATHS

Hydrophone channel signal paths are shown in figure 5. The hydrophone internal capacity and a resistor at the input to the preamplifier form a network which shapes the frequency response of the preamplifier to a +6 db per octave slope. The purpose of this frequency-response shaping is to increase the effective dynamic range of the system by compressing the range of levels seen by the 1/3-octave analyzer. This is shown graphically in figure 4.

Two gain settings are possible with the preamplifier by grounding out a 3.16 KΩ resistor in the preamplifier with a gain latching relay, which is controlled from the on-deck console. The output of the preamplifier is fed to the 1/3-octave Ortholog Filter Analyzers, whose outputs are d.c. voltages corresponding to the 1/3-octave band level sampled. The outputs of the third-octave analyzers are switched sequentially to the Voltage Control Oscillator (VCO) by a ring counter switching relay. The ring counter is advanced by a clock pulse at the rate of one 1/3-octave band output per second. The frequency of the VCO is linearly-modulated with voltage about a center frequency of 5.4 KC.

The VCO signal output is fed to a line driver, where the impedance is lowered and sufficient power developed to drive the tow cable. At the on-deck Sub-assembly, the VCO signal is recorded on the data channel of the dual-channel magnetic tape recorder. The VCO signal is also converted back to d.c. levels by the discriminator. The d.c. signal levels are conditioned by a Philbrick Amplifier to be accepted by the USL Automated Data System (ADS), where they are read out and plotted as 1/3-octave band level vs 1/3-octave center frequency.

Calibration potentiometers for each 1/3-octave band are provided in the Automated Data System to compensate for any frequency-response shaping in the Gulton system. The data recorded on magnetic tape can also be read out by playing back through the discriminator and the Automated Data System.

During sequency through the 27 frequency bands of the Analyzer, the clock pulse which drives the analyzer switches also drives a monostable multivibrator. The one-millisecond pulse thus obtained is fed to the input of the VCO to introduce a frequency transient. Appearance of the transient at the discriminator output triggers the Deck Unit Pulser, which supplies a 1-millisecond pulse to synchronize the USL Automated Data System with the frequency analyzer of the Gulton System.

Accelerometer channel signal paths are shown in figure 5. Signal paths are essentially the same as for hydrophone-channel operation, except that no frequency-response shaping network is used. A charge amplifier is switched into the preamplifier input circuit in place of the frequency-response shaping network to provide a compatible load for the charge accelerometers, and for low-impedance commutation of the channel-selection relay contacts.

Potentiometric channel signal paths are shown in figure 5. The sensor in this mode of operation is a resistive transducer which acts as one leg of a balanced bridge circuit. The voltage produced by imbalance of the bridge is fed directly to the voltage control oscillator through the channel-selection relay contacts.

PROGRAMMER

Figure 6 is a functional block diagram of the programmer control system. The deck unit programmer contains a 13-stage ring counter with 12 sensor-selection positions and one reset position. The ring counter consists of 13 SCS stages with reed relays as part of the resistance in the load circuit. The ring counter is either advanced or cleared by an input pulse, dependent on the duration of the pulse.

The fish unit programmer contains an identical ring counter which is sequenced with the same control pulses. The relays of this counter are used to switch the transducer outputs to either the preamplifier input or VCO input, depending on the transducer involved. The accelerometer and hydrophone outputs are fed to the preamplifier, and the potentiometric inputs are fed to the VCO. Only one stage in the ring counter can conduct at any one time, so only one transducer output is analyzed at a time.

In addition to the advance and clear commands required for the ring counter, a calibrate function is also required. Upon receipt of the calibrate command the 1-cps clock oscillator is gated to the 13-position ring counter by setting a flip-flop. The ring counter is advanced until position 7 is reached, at which time the flip-flop resets and the gate is opened. While the gate is closed, calibrated resistors are connected to the bridge circuits of the potentiometric channel inputs. The calibrate command pulse also actuates the bistable gain latching relay, which controls the 15 db gain change of the preamplifier.

A pulse width modulation system is incorporated into the on-deck unit, and a corresponding detection system is incorporated into the fish unit to route command pulses. Pulse widths of 1.5 msec, 3 msec, and 4.5 msec are used for the advance, clear, and calibrate functions, respectively.

Any transducer channel can be skipped by means of the skip switches incorporated on the deck unit console. An additional advance pulse is generated for each closed switch, which constitutes an advance command for the fish unit, thus skipping the channel of the closed switch.

SUMMARY

The Gulton Industries, Incorporated, Noise Analysis System provides a useful instrumentation system for VDS research. Its main advantages are:

(1) The system is capable of monitoring 12 separate input transducers (6 potentiometric, 3 hydrophone, and 3 accelerometer), using only 4 conductors of the tow cable to carry data and control information between the ship and the towed body.

(2) The system is capable of automatically analyzing, in 1/3-octave band levels, the noise spectrum seen by the hydrophone and accelerometer transducers mounted in strategic locations in the towed body.

(3) Analyzing is performed in the underwater unit, permitting short cable runs from sensor to amplifying and analyzing circuitry.

(4) Data is transmitted to shipboard storage and readout equipment by a frequency-modulated carrier, thus eliminating tow cable loss as a calibration factor.

(5) The system is compatible with USL Automated Data System to provide a direct X-Y plot of Level vs. Frequency.

LIST OF REFERENCES

(a) Gulton Industries, Inc. "A Noise Analysis Data System", Technical Proposal for the U. S. Navy Underwater Sound Lab. P-MB-4-62, of May 1962 (U)

(b) A. Donn Cobb, "Comments on Gulton Industries Proposal for A Noise Analysis Data System", USL Technical Memorandum No. 932-291-62 of 28 December 1962 (U)

(c) Gulton Industries, Inc., "Technical Manual for Towed Vehicle Instrumentation System", Manuscript Copy, two volumes.

John Robichaud

JOHN ROBICHAUD
Electronic Engineer

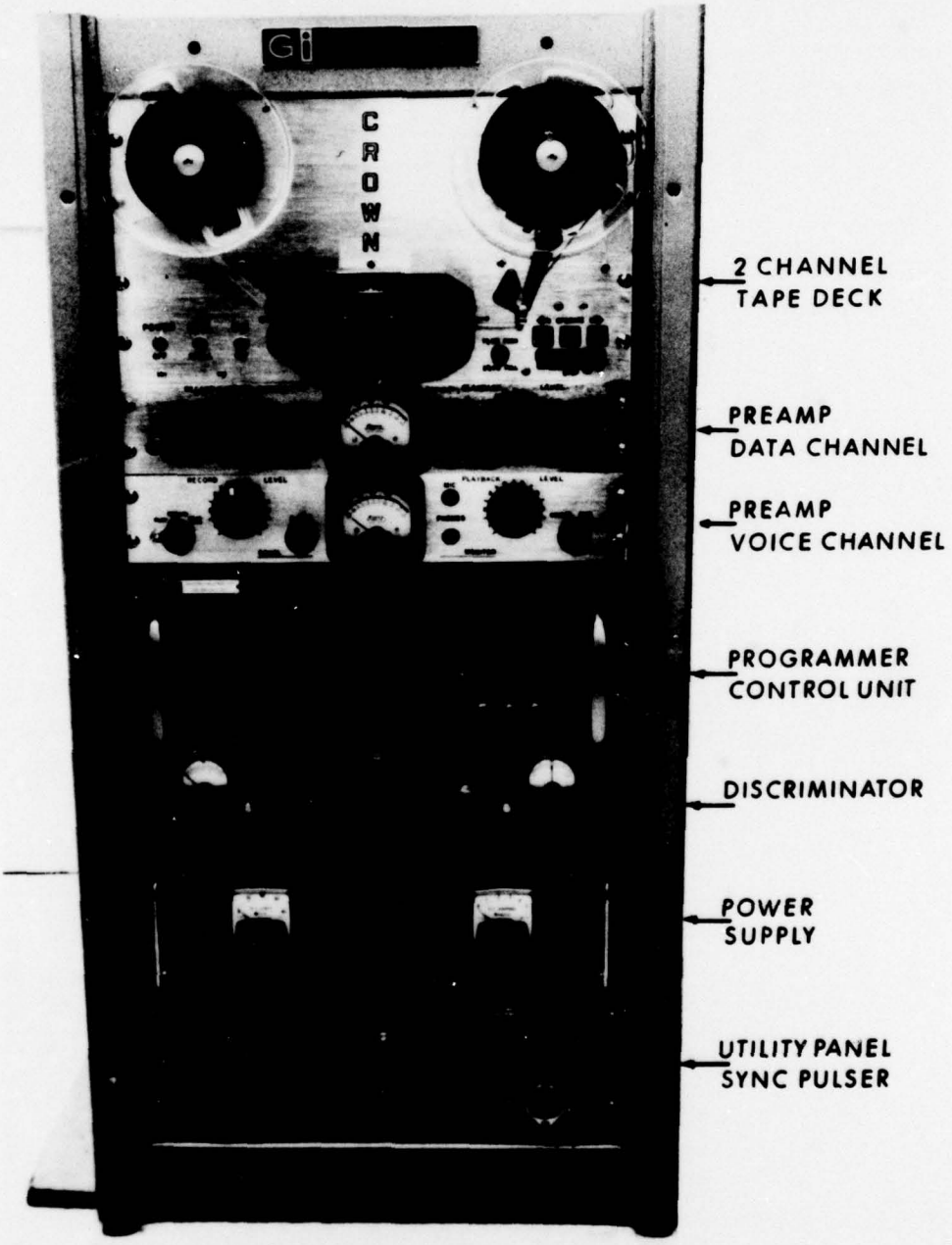

Fig. 1 - Gulton Towed Vehicle Instrumentation - Deck Sub-System

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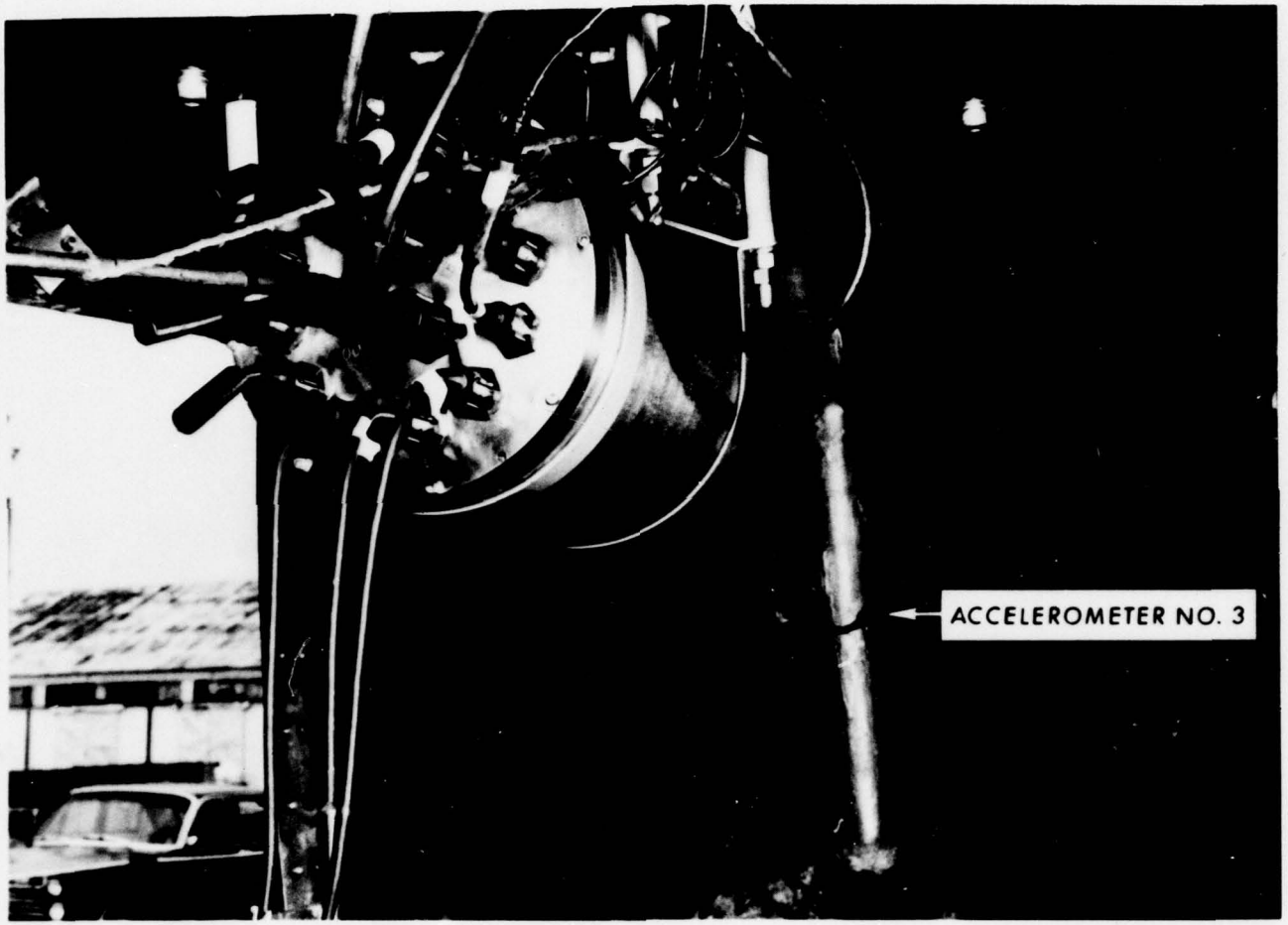

Fig. 2 - Gulton Towed Vehicle Instrumentation - Underwater Sub-System

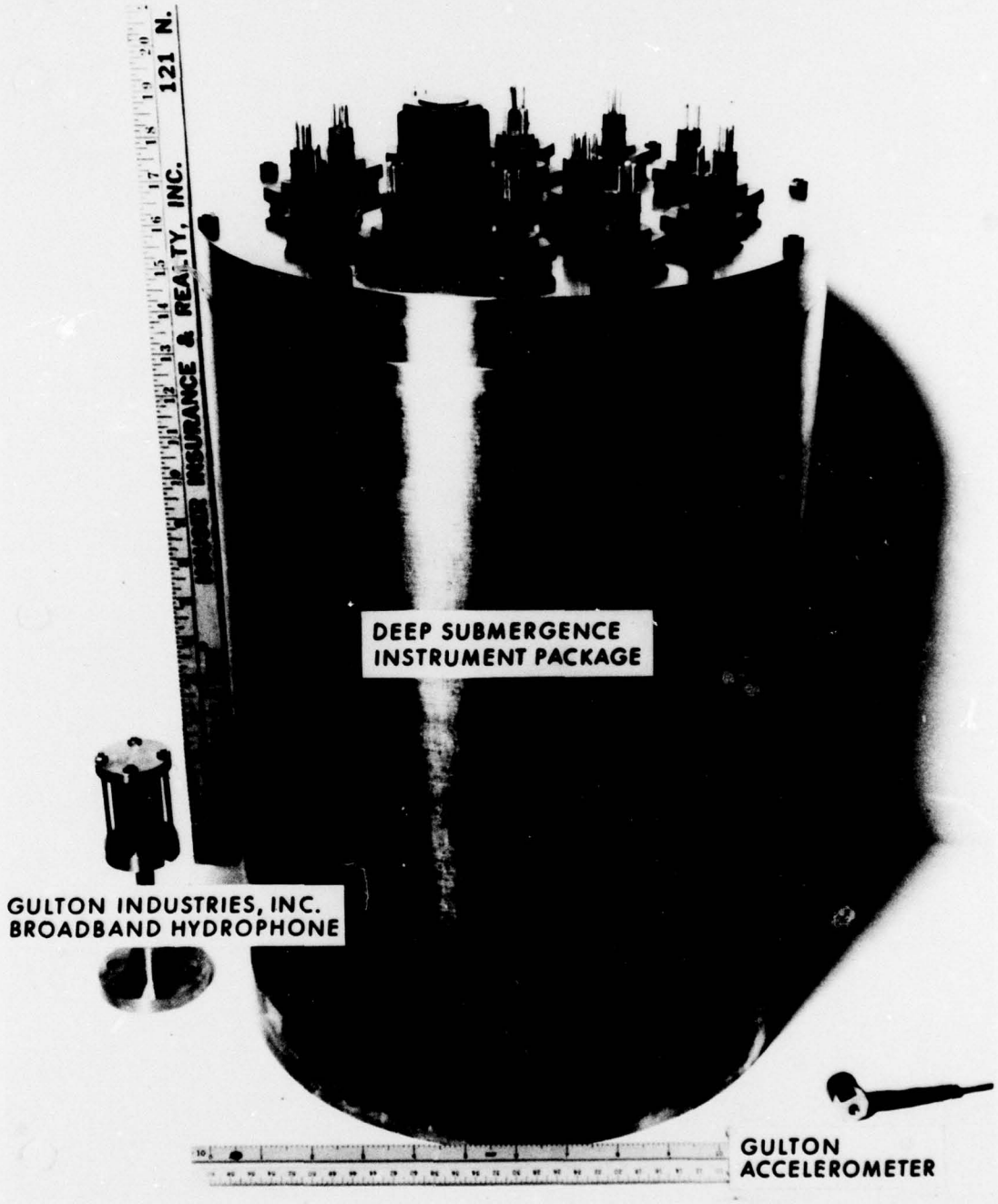

Fig. 3 - Gulton Towed Vehicle - Underwater Sub-System Installed in SQA-11 Fish on USS Witek

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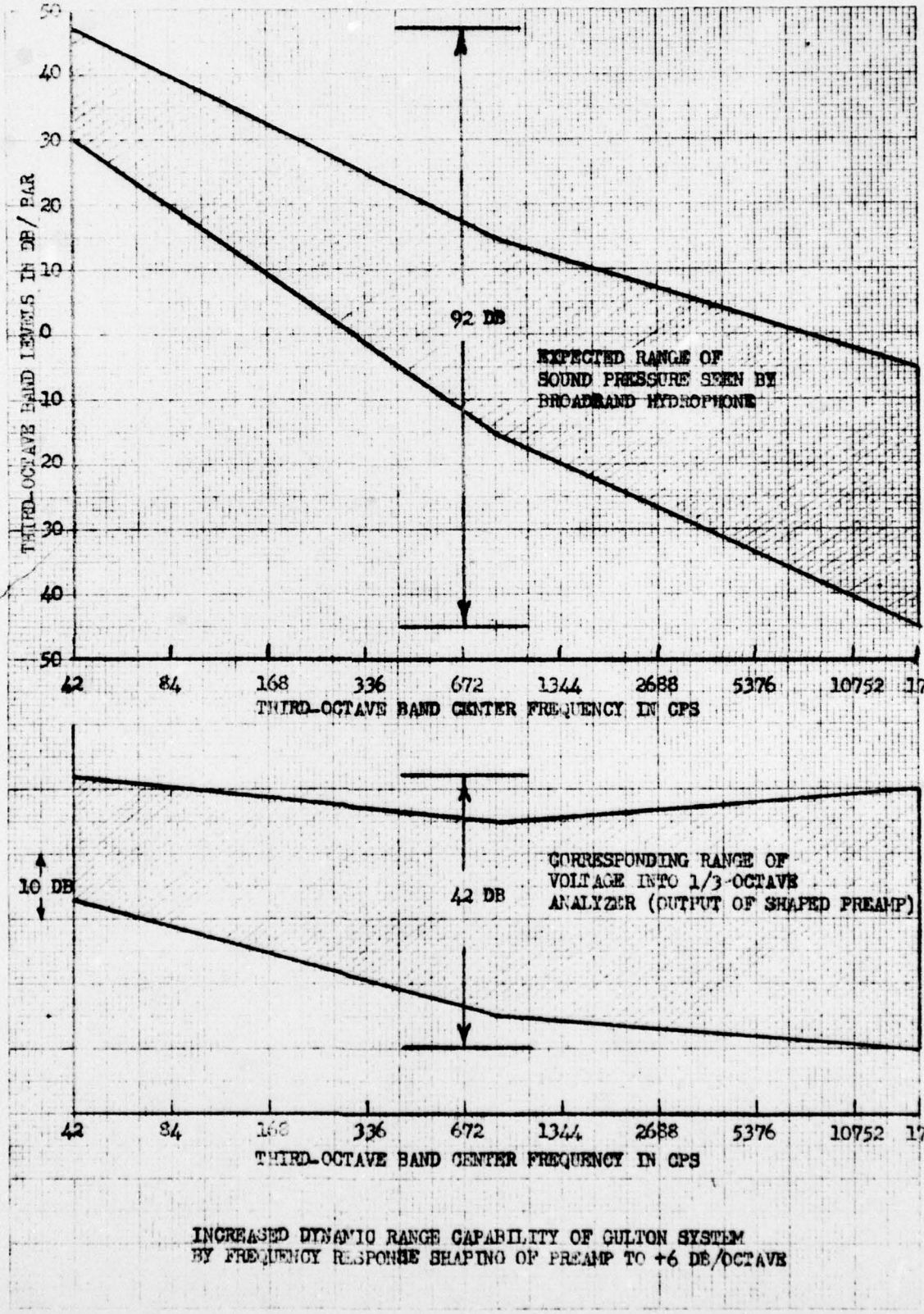

INCREASED DYNAMIC RANGE CAPABILITY OF GULTON SYSTEM
BY FREQUENCY RESPONSE SHAPING OF PREAMP TO +6 DB/OCTAVE

FIGURE 4

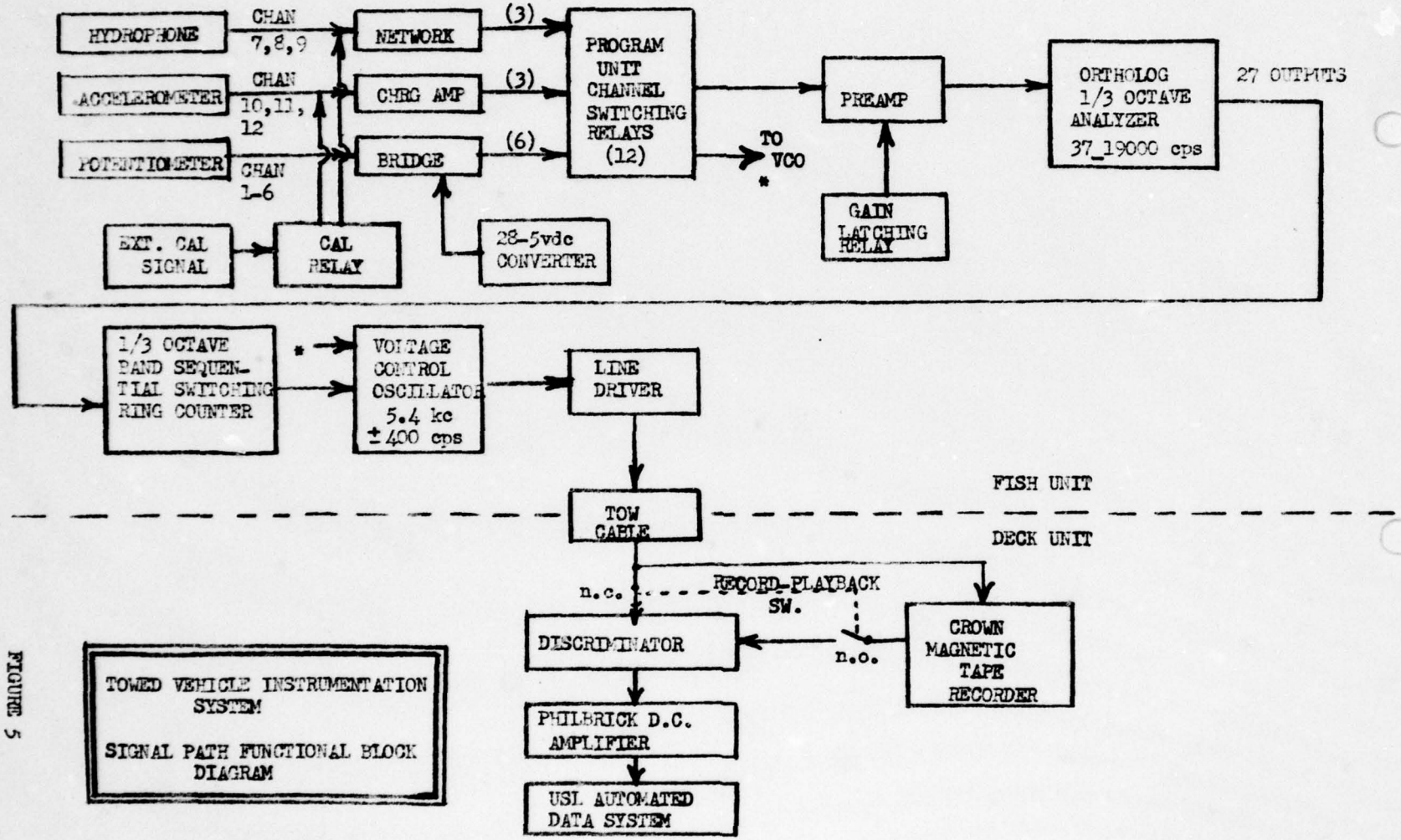

FIGURE 5

TOWED VEHICLE INSTRUMENTATION SYSTEM

SIGNAL PATH FUNCTIONAL BLOCK DIAGRAM

FIGURE 5

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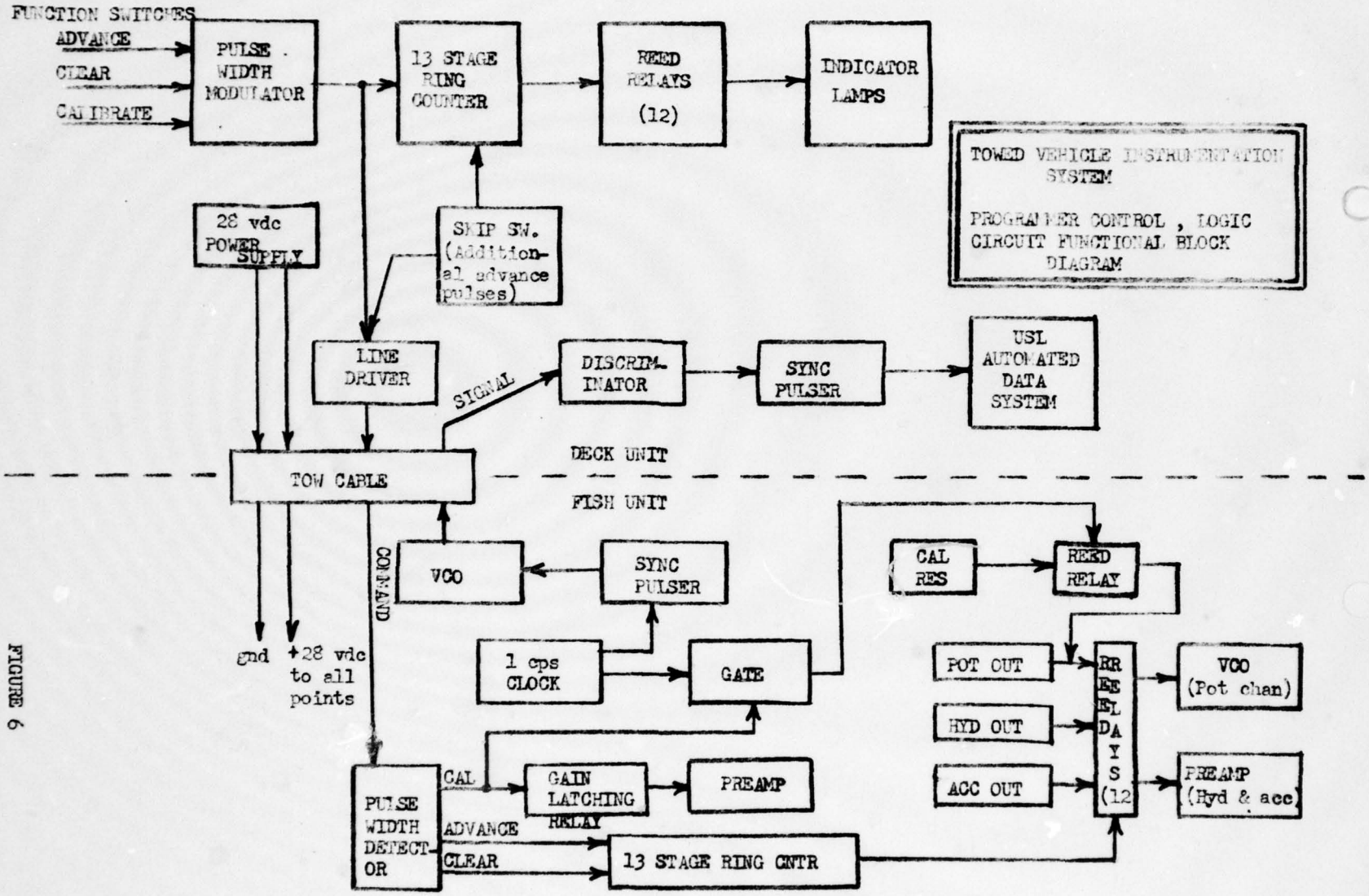

FIGURE 6

FIGURE 6

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